A CASE REPORT: 3D SIMULATION ASSISTED FOR TREATMENT OF COMPLEX PROXIMAL HUMERUS

Nguyen Anh Sang*,, Pham Chanh Trung*, Tran Khoi Luan*, Tran Quoc Doanh***

ABSTRACT

A 65-year-old female patient had a traffic accident on August 7, 2024. After that, the patient received initial emergency care at the local medical facility and was found to have a complex proximal humerus fracture; a temporary Desault bandage was worn. The left wrist and hand were moveable. We describe a case of a complex proximal humerus fracture that was osteosynthesis by locking-plate with a 3D simulation supported to talk over the treatment method for the case.

Keywords: proximal humerus fracture, osteosynthesis, 3d simulation

I. INTRODUCTION

Fractures of the proximal humerus include fractures of the anatomical neck, greater trochanter, lesser trochanter, and surgical neck of the humerus. This type of fracture accounts for approximately 30 to 40% of all humeral fractures and are the third most common fracture after fractures of the distal radius and proximal femur in people over 65 years of age [1]. Currently, thanks to the development of medicine, surgical treatment of displaced proximal humerus fractures has recorded very positive initial results. 3D simulation from computed tomography (CT) is an important step forward when evaluating the degree of displacement of complex fractures. We describe a case of a complex proximal humerus fracture that was osteosynthesis by locking-plate with a 3D simulation supported to talk over the treatment method for the case.

II. CLINICAL CASE SUMMARY

A female patient with her name is Pham Thi T., born in 1959 and admitted to the hospital complaining of left shoulder pain after a fall due to a traffic accident. Through examination, the patient reported that on August 7, 2024, the patient fell off a motorbike in Dong Nai. After the fall, she regained consciousness and felt pain in her left shoulder. The patient was initially examined at a local medical facility and found to have a complex proximal humerus fracture. She was given a Desault bandage to temporarily fix the fracture and then taken to Military Hospital 175 to await surgery. At the time of admission, her left shoulder was swollen, bruised, pressing on the proximal humerus was painful, unable to move the left shoulder, and the fingertips of the left hand were warm and pink. The X-ray image showed a complex proximal humerus fracture into 3 parts (Figure 1), however, on the X-ray, it was difficult to assess the fracture.

* *Military Hospital 175*
** *Vietnam Military Medical University*
Responsible person: Tran Quoc Doanh
Email: drtranquocdoanh@gmail.com
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We explained to the patient that a CT scan was needed to assess the fracture more comprehensively. After the CT scan, we used RadiAnt DICOM Viewer (https://www.radiantviewer.com) (Figure 2) and 3D Slicer software (Figure 3) to simulate the fracture of the proximal humerus. After that, we presented to the patient that the patient would undergo surgical reduction, fixation of the fracture with screws and plates, and the risks and recurrence of complications during and after surgery. When performing the surgery, we chose the (anterior) deltopectoral skin incision with a length of about 14-15cm, dissected to expose the fracture, removed the hematoma and bruised tissue attached to the fracture head, reduction the fracture to the anatomical position with the support of fluoroscopy equipment, and osteosynthesis by locking plate. After checking with the fluoroscopy screen, seeing that the fracture has been reduced to the required level, proceed to irrigate, suture to close the surgical wound. After surgery, the patient was given a reinforced Desault bandage to reduce pain. Upon discharge, the patient's pain improved and she was satisfied with the treatment results.

Table 9: ***Summary of some characteristics of this case***

Number	Variable	Value
1	Age	65
2	Gender	Female
3	Causes of injury	Traffic accident
4	Injured side	Left
5	Dominant hand	Right
6	Neer classification on X-ray Group Number of fracture parts	 IV 3
7	Neer classification on 3D simulation Group Number of fracture parts	 IV 3, greater tuberosity fracture is complicated
8	Assessment of the clarity of fracture displacement characteristics by physicians in the department	Three-dimensional simulations are evaluated more clearly and in more detail than x-rays and CT scans
9	Surgery time Plan Reality	 120 min 90 min
10	Skin incision	(anterior) deltopectoral
11	Number of C-arm tests	10 times
12	Patient satisfaction Preoperative consultation Health at discharge	 Satisfied Satisfied

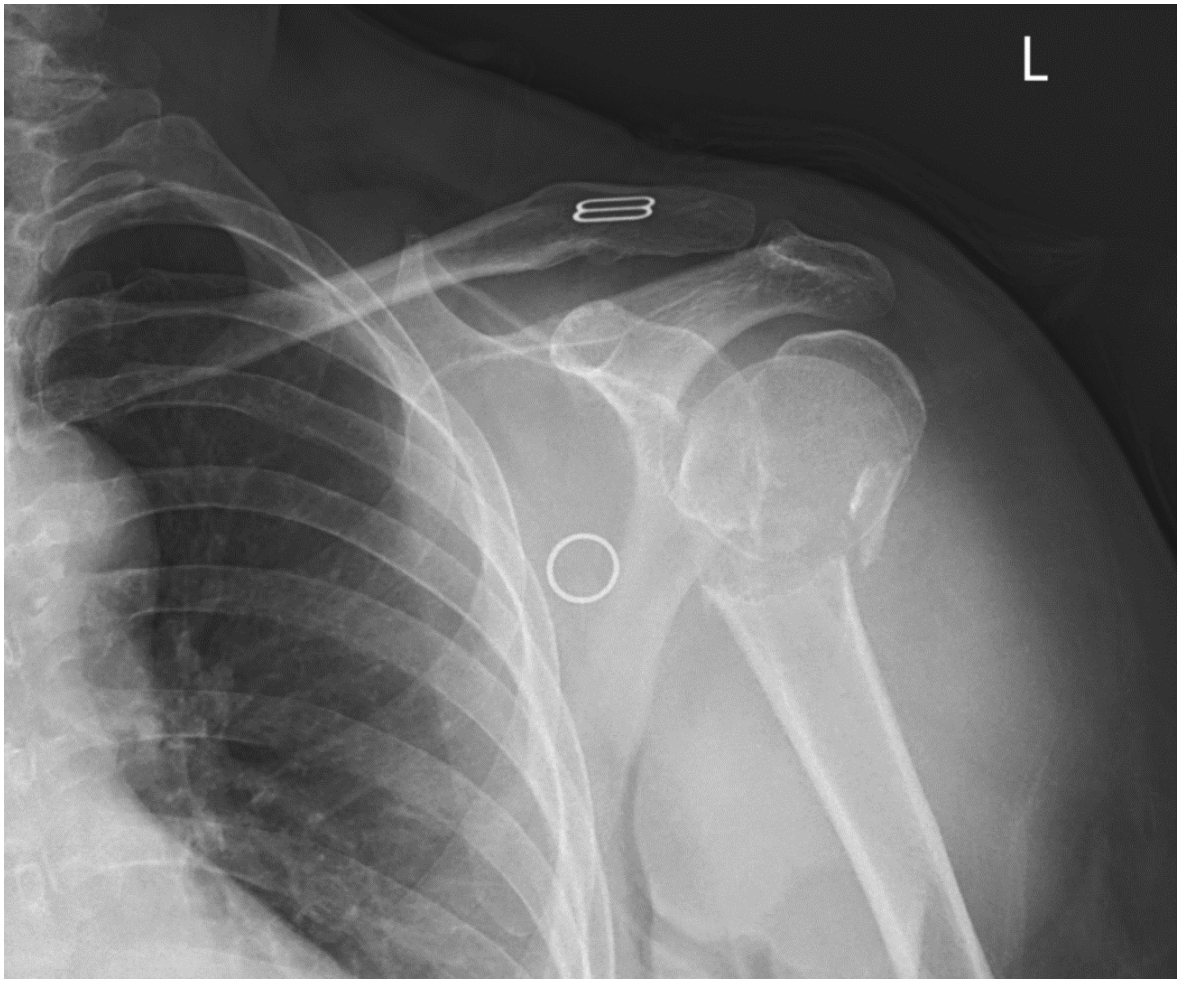

Figure 1: ***X-ray of the patient's left proximal humerus fracture***
(Source: Author's research materials)

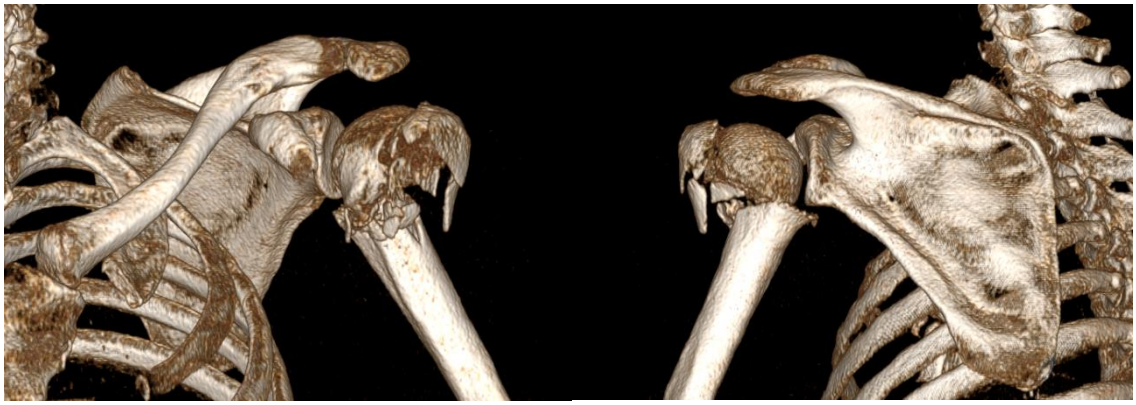

Figure 2: ***3D simulation of proximal humerus fracture by RadiAnt DICOM Viewer***
(Source: Author's research materials)

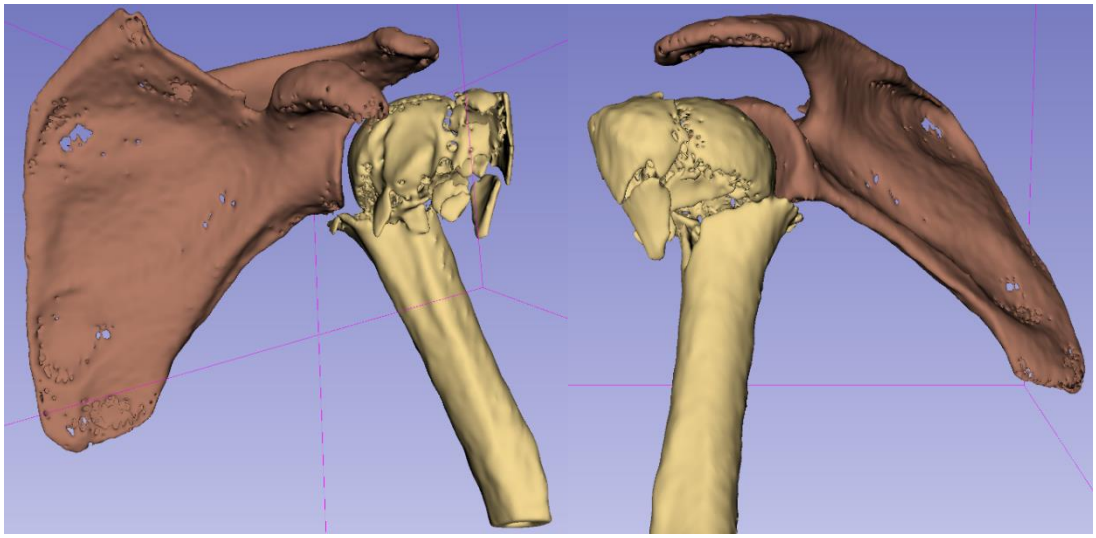

Figure 3: 3D simulation with color-specific segmentation of humerus fracture by 3D Slicer

(Source: Author's research materials)

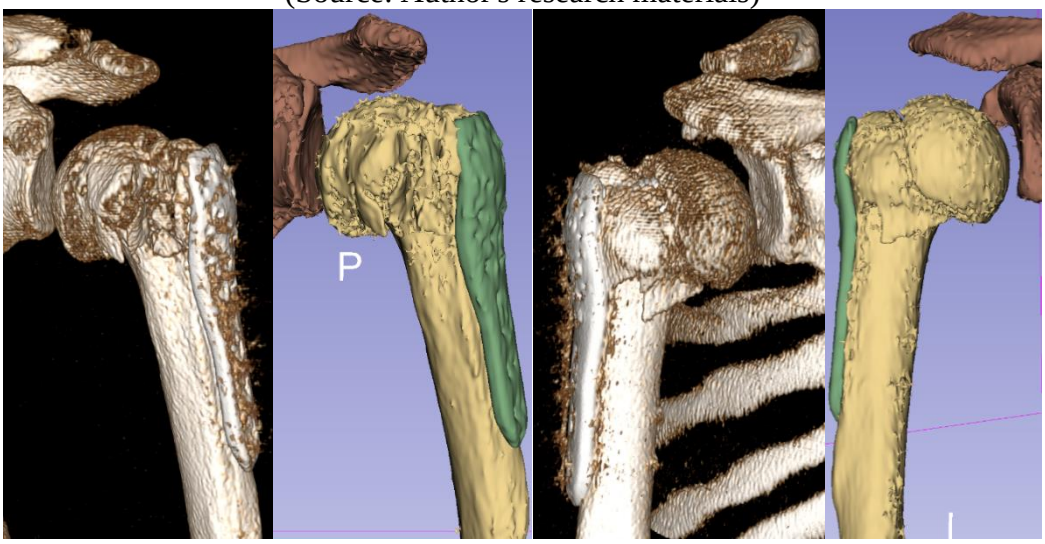

Figure 4: *3D simulation from CT scan after osteosynthesis*

(Source: Author's research materials)

III. DISCUSSION

The proximal humerus fracture in this case was assessed using the following tools:

- Anteroposterior X-ray image of the shoulder joint (Figure 1)
- CT scan image
- After being extracted, DICOM files will be processed by RadiAnt DICOM Viewer (Figure 2) and 3D Slicer (Figure 3) software. These software processes to create 3D simulation images of the proximal humeral head and structures around the shoulder joint, segmenting the components into details with different display colors.

The literature describes X-ray as the preferred initial paraclinical test for traumatic shoulder pain [2]. However, in cases with complex fractures, the anteroposterior or lateral planes may not be able to help the clinician clearly assess the degree of fracture displacement. At this time, a CT scan is absolutely necessary, because a CT scan

helps make a more accurate diagnosis, helping to predict better treatment [3].

Along with the development of technology, the orthopedic trauma major has applied digital technology to paraclinical tests to support the diagnosis of diseases. In recent years, three-dimensional simulation has been gradually applied in the field of orthopedic trauma due to its ability to display the degree of displacement of the fracture. 3D simulation images reconstructing the proximal humeral head on CT scans, such as in this report, clinicians have assessed the fracture status more specifically and in more detail when evaluating on 3D simulation images compared to X-rays of the anterior-posterior shoulder joint (Table 1).

The initial estimated surgical time was approximately 120 minutes, but the actual surgery took 90 minutes (Table 1), demonstrating the benefits of more detailed observation of the fracture characteristics. This method allows us to fully understand the fragmentation status of the fragments, predict possible bone defects, and thus predict the possibilities of intraoperative treatment to better plan the surgery.

Communication between the doctor and the patient and the patient's family by showing them a 3D simulation image. This helps patients and their families understand the severity of the injury they are suffering from and the difficulties and risks during and after surgery, thereby increasing the ability to comply with the instructions and advice of medical staff.

Preoperative planning of the case also takes more time, in addition to routine preparations such as examination, investigation of associated pathologies, review of preoperative tests, we also have to prepare to create a 3D simulation, which can take a few hours for skilled staff. However, careful preparation has brought benefits to the patient in shortening the surgery time, creating a better psychological contact between medical staff and patients, better treatment compliance, and patient satisfaction upon discharge.

IV. CONCLUSION

The recent development of 3D simulation imaging has great potential in the field of orthopedic trauma. The application of 3D simulation of the upper humeral head reconstruction has the ability to clearly display the fracture, making it easier to assess the fracture status than X-ray and CT scan without simulation. 3D simulation should be used for preoperative planning of fracture treatment, especially for fractures of the articular head and complex fractures, and can also create a realistic model from the three-dimensional simulation for experimental correction before surgery on patients..

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